REMARKS

Reconsideration and withdrawal of the outstanding rejection is respectfully requested. Supportive discussion/rebuttal arguments directed thereto follows.

Claims 1-17, 37, 39, 41-45, 47 and 49-58 are currently pending in this application of which claims 1-5, 39, 43, 47, 49 and 58 were amended. (Claims 18-36, 38, 40, 46 and 48 were earlier canceled.)

All of the independent claims were amended to more particularly highlight the various featured aspects thereof in a manner which is clearly defining over the cited art documents, as applied with regard to the outstanding rejection. Specifically, with regard to the method of manufacture of the invention, the claims have been amended to more particularly highlight the cleaning phase thereof for both before as well as subsequently to the formation of the "cap conductive film" (e.g., 26c, 35c, etc.), as an example showing of patentably defining aspects of the present claimed subject matter over that previously known including even over the combined teachings of the art documents as presently cited in the outstanding rejection.

In accordance with the present invention, due to the formation of a cap conductive film, for example, a tungsten (W) metal by selective growth or preferential growth on the wiring, the wiring (e.g., 26, 35, etc.) does not directly contact with the insulating films, such as the silicon nitride film and the silicon oxide film. Rather, the wiring is in contact with the cap conductive film which leads to significant electromigration reduction as well as a number of other significant improvements. (Page 18, paragraph [0081] to page 20, paragraph [0089], of the Substitute Specification and Figs. 22(a)-24(b), 27 and 28, etc.) When contaminant metal remains on the insulating film (e.g., 23, 33, etc.) after polishing such as by CMP of, for example, copper film wiring (e.g., 26b, 35b, and the like), the process of

forming the cap conductive film (e.g., 26c, 35c, etc.) would lead to undesirable growth on the contaminant metal remaining on the insulating film during the selective deposition step of, for example, tungsten (W). This is caused from a breakdown of selectivity which may lead to a lower yield due to, for example, short-circuiting. The method of manufacture according to the present invention, however, overcomes this. For example, after completion of the polishing of the copper such as it relates to step (b) of claim 1, etc., the substrate surfaces (e.g., including the surfaces of the copper film 26b, 35b, etc., and the silicon oxide film 23, 33, etc.) are cleaned with a cleaning solution such as a solution for removing foreign matter in contaminant metals. Following this, the cap conductive films (e.g., tungsten films 26c, 35c, although other conductive film materials may be used as noted from the claims) are formed on the wirings by selective or preferential growth. Through employing such cleaning processes prior to forming a "cap conductive film," as called for in each of independent claims 1-5, 39, 43, 47, 49 and 58, good selectivity/preferential ability is ensured such as in connection with the formation of the cap conductive films (e.g., 26c, 35c, etc.). As noted in the Specification such as on page 18, paragraph [0084], although the example embodiments show the formation of the cap conductive film using tungsten material, other types of conductive film layers may also be employed including, but not limited to, TiN, Ta, TaN, WN or Ni film (see dependent claim 9, etc.). As to the cleaning process employed, prior to the formation of the cap conductive film, examples thereof are set forth in connection with dependent claims 15-16, 41, 51 and 52.

According to a further aspect of the method of manufacture of the present invention, additional cleaning is performed subsequently to the formation of the cap conductive film. That is, after the selective or preferential growth of the tungsten (W) film on the wiring, a further cleaning step is added in the process, namely, the

surface of the insulating film (e.g., 23, 33, etc.) and cap metal are cleaned which further enhances the reliability of the Cu wiring. This featured aspect is set forth in claims 1 and 2, part (e) thereof; in claims 3-5, parts (l) thereof; in claims 39 and 43, part (f) thereof; in claims 47 and 49, part (g) thereof, and in claim 58, part (f) thereof. An example discussion of this is given on pages 44-45 of the Substitute Specification and, in particular, paragraphs [0184]-[0185]. Additional details of the cleaning phase subsequently to the formation of the cap conductive film is set forth with regard to the dependent claims such as claims 17, 53 and 54.

In accordance with the scheme as that now set forth in each of independent claims 1-5, 39, 43, 47, 49 and 58 and as further defined according to the corresponding dependent claims thereof, the reliability of the copper interconnection which calls for, for example, the forming of a cap barrier metal on a buried copper interconnection is enhanced considerably. For example, the copper surface is capped by the cap conductive film (e.g., cap metal of W) so that the wiring (e.g., Cu wiring) is not directly in contact with the insulating films. Thus, since the copper wiring interfaces only with the cap conductive film (e.g., tungsten metal), transference of copper ions such as to another copper line (wiring) is prevented. The present inventors were able to successfully achieve this through the action of forming a "cap conductive film" (e.g., a cap metal barrier such as W metal, etc.) on the wiring (e.g., copper) surface by, for example, selective plating.

As earlier discussed in these remarks, and as more extensively discussed in the Specification, selective plating tends to undesirably also grow a metal on the insulating film surface in addition to the wiring surface (i.e., copper surface). Breakdown of plating selectivity as a result of undesired metal growth on the insulating film surface may lead to, for example, short-circuiting of wirings thereby lowering the effective yield of the manufactured device. Through effecting a

cleaning phase of the insulating film surface before selective plating of the cap conductive film, in a manner as now set forth in each of the independent claims, the selectivity of metal plating on the wiring (e.g., copper) surface as well as preferential ability becomes improved considerably. (Paragraphs [0174] - [0175] on page 42 of the Substitute Specification.) Further, by additionally conducting a cleaning subsequently to the formation of the cap conductive film, such as by selective growth (i.e., selective plating of metal), the undesired cap conductive film grown on the surface of the insulating film is removed, which leads to further prevention of breakdown of plating selectivity. (Paragraphs [0184] - [0185] on pages 44-45 of the Substitute Specification.)

It is submitted, such aspects of the present invention directed to the cleaning before and after the formation of the cap conductive film, as now set forth in each of the independent claims, are not the same as that typically associated with known wafer cleaning steps such as conducted during a wafer processing. Typically, wafer cleaning is conducted for purposes of removing residue or contaminants that remain subsequently to the etching phase or CMP processing. However, both the pre-cleaning as well as the post-cleaning phase according to the method of the present invention are conducted for the purposes now stated in each of the independent claims 1-5, 39, 43, 47, 49 and 58. The method for manufacturing a semiconductor integrated circuit device as that presently set forth in these claims as well as in the corresponding dependent claims thereof could not have been realized even in view of the combined teachings of the cited references.

Claims 1-17, 37 and 39-58 were rejected under 35 USC §103(a) over Uozumi (U.S. Pat. No. 6,261,953) in view of Omura (U.S. Pat. No. 6,028,362), Berman (U.S. Pat. No. 5,893,756) and Chen (U.S. Pat. No. 5,723,387). (Chen is a newly applied reference.) As will be shown hereinbelow, in conjunction with the above

discussion, the invention according to these claims, as presently amended, could not have been rendered obvious in the manner as alleged in the outstanding rejection. Therefore, insofar as applicable, this rejection is traversed and reconsideration and withdrawal of the same is respectfully requested.

Uozumi disclosed a process of producing a copper damascene interconnection and selective metal embedding on an upper surface of the copper damascene interconnection. Uozumi disclosed a scheme featuring the formation of a cap metal by sputtering a metal film over an embedded copper layer and insulating film. Then, the metal film formed on the insulating film is removed by a polishing process (CMP), which leads to burying the metal layer 4 in the upper portion of the wiring groove (see Fig. 1D). Uozumi, it is submitted, did not teach a scheme in which a barrier metal is formed on a Cu film by selective CVD and, also, the cleaning of the surface of the insulating film (e.g., 1) and Cu film. In fact, Uozumi neither disclosed nor suggested a pre-cleaning phase of the copper and insulating film surface, i.e., before the cap metal plating, nor disclosed or suggested a post-cleaning phase of a surface of the cap metal and insulating film surface. (Column 7, lines 40-50, in Uozumi.)

Omura disclosed a method which features the forming of cap layers (e.g., 60d, 60s) on respective interconnect grooves (e.g., 44S, 44D). The cap layers according to Omura are formed by depositing a metal film over both the copper surface and the insulating film surface and then removing that portion of the metal formation that is on the insulating film surface so that only the portion of the cap metal that is on the copper film surface remains. That is, the cap layers 60s and 60d in Omura are not selectively grown in the interconnect layer, contrary to that in each of the independent claims 1-5, 39, 43, 47, 49 and 58. It is submitted, therefore, Omura neither disclosed nor suggested forming the cap layers 60s, 60d

by selective CVD method nor taught a scheme calling for a pre-cleaning of the copper and insulating film surface before the cap metal plating selectively nor disclosed or suggested the post-cleaning phase (of the present invention) of the formed cap metal surface and insulating film surface. (Column 14, lines 46-51, in Omura.)

Berman disclosed a cleaning process "for inhibiting corrosion in metal plugs that may result from post metal CMP cleaning steps." In this regard, Berman taught a scheme which uses hydrofluoric acid and ethylene glycol for removing the contaminated dielectric layer and inhibit corrosion of the metal plug. (Column 4, lines 31-40, in Berman.) It is submitted, Berman neither disclosed nor suggested a post-cleaning process regarding the surface of the cap metal and insulating film surface as that required by the present invention.

In terms of the present invention, Chen, it is submitted, only disclosed a scheme calling for copper CMP, selective plating on the copper surface and cleaning of the plated surface. Chen's scheme calls for cleaning and drying substrate (see column 3, line 56 and column5, line 28; however, Chen did not specifically describe the cleaning phase of the wafer. Chen, it is submitted, neither disclosed nor suggested a scheme calling for (i) a pre-cleaning process of the copper and insulating film surface before the formation of the cap metal plating (e.g., 18 in Fig. 4D) such as for improving the selectivity of metal platings, nor (ii) a post-cleaning process regarding the cap metal surface and the insulating film surface for the removal of plated metal from the insulating film surface that is caused from a breakdown of the metal plating selectivity, which are required according to the present claimed subject matter.

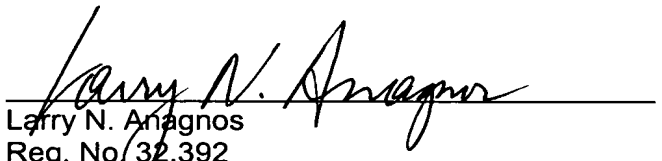
Since Uozumi, Omura, Berman and Chen were shown to be deficient in a number of the featured aspects of the present invention, especially with regard to

the cleaning phases of the method of manufacture, and since the deficiencies of one or more of the references were not overcome even in view of the collective teachings of all of the references, the present invention as now called for in each of claims 1-5, 39, 43, 47, 49 and 58 and as further defined by the corresponding claims thereof, could not have been realizable.

Therefore, in view of the amendments presented hereinabove, together with these accompanying remarks, reconsideration and withdrawal of the outstanding rejection as well as favorable action on all of the presently pending claims and an early formal notification of allowability of the above-identified application is respectfully requested.

To the extent necessary, applicants petition for an extension of time under 37 CFR §1.136. Please charge any shortage in the fees due in connection with the filing of this paper, to the Deposit Account of Antonelli, Terry, Stout & Kraus, LLP, Dep. Acct. No. 01-2135 (501.39868X00), and please credit any excess fees to such deposit account.

Respectfully submitted,
ANTONELLI, TERRY, STOUT & KRAUS, LLP



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